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# Final report to the Thomas Smythe Foundation, Inc. : concerning geophysical reconnaissance of a portion of the area offshore from Jamestown Island, Virginia

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FINAL REPORT TO THE

THOMAS SMYTHE FOUNDATION, INC.

CONCERNING

# GEOPHYSICAL RECONNAISSANCE OF A PORTION OF THE AREA OFFSHORE FROM JAMESTOWN ISLAND, VIRGINIA

submitted by

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## INTRODUCTION

As stated in the (modified) proposal for a *Geophysical Reconnaissance of a Portion of the Area Offshore from Jamestown Island, Virginia,* dated 11 September 1990, we undertook an acoustic survey of a limited area of the nearshore between the Virginia Department of Transportation Jamestown-Scotland Wharf Ferry Pier and Church Point along the north east shore of Jamestown Island (Figure 1). The project involved operating a sea-floor mapping system and a sub-bottom profiling system in shallow water. The surveys were performed on March 20 and 21, 1991, utilizing one of the Institute's 28 foot long, outboard workboats.

The reasoning behind the effort was two-fold. Since Jamestown Island was colonized in 1607, local, relative sea-level has risen approximately one meter. Also, the shoreline has moved (eroded) significantly, partly as a result of the rise in sea-level. Together these phenomena might contribute to the present day location of colonial artifacts offshore. If the shoreline migrated through the site of a major structure, it would be reasonable to expect that some items pertaining to that structure might remain in place. The subsequent continuing rise in sea level would further drown the remnants.

Unfortunately the drowning of the area exposes the bottom to the potential for great alteration. The dynamic processes of currents and waves resuspend and transport sediment, burying, destroying, or moving items that were along the bottom. Man can further exacerbate the problem. Turbulence generated by vessels adds to the naturally occurring dynamics of the water mass. Things physically impacting the bottom, anchors, boats grounding, and such, can further disturb the bottom.

As will be discussed, we found no indications of colonial-age artifacts or utilization of the area.

## EQUIPMENT AND METHODS

Navigation was by loran-C. Fixes, the latitude and longitude calculated by the loran microprocessor aboard the vessel, were recorded upon the data as they were taken. Because loran was not primarily designed for use in the tidal rivers, the loran derived latitude and longitude do not agree with latitude and longitude measured from known locations on a chart. By comparing the loran derived with the chart derived locations of known sites, we determined that in the vicinity of Jamestown Island, there is a nearly constant offset; the loran provided positions that were displaced from the real by 1.95 km at 058°. The geographic coordinates shown on the included track lines maps are the loran derived coordinates.

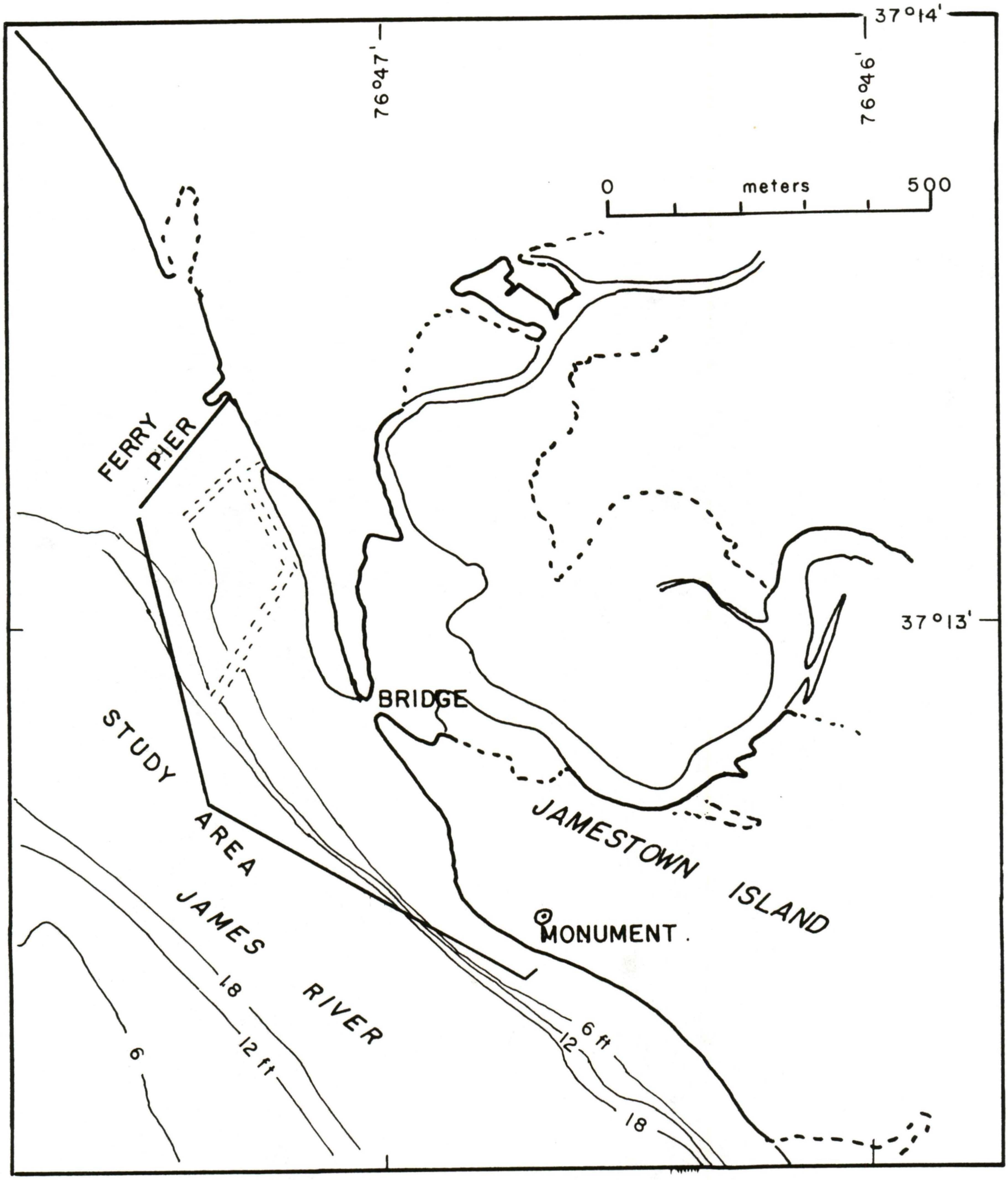



Figure 1. Location of study area.

The side-scan sonar unit was an EG&G SMS 960 operating at 105 kHz recording a swath nominally 200 m wide (100 m half-width). In real time the system produces a paper record, sonogram, that automatically is corrected as to lateral scale and is approximately corrected to along-track scale. The data were not recorded on magnetic media.

The recorded image on the side-scan printer depicts variations in the roughness of the sea-bed on the basis of variations in acoustic backscatter. Very small scale changes in roughness, such as would be caused by variation in sediment grain-size, appear as broad changes in darkness or tone. A lighter or brighter image is indicative of coarser, sandier sediment; a darker image generally is indicative of finer-grained sediments that tend to absorb the acoustic energy and tend also not to scatter or return much of the incident energy. Larger scale features, bedforms and anthropogenic elements, appear with a relatively high degree of clarity. The strong relief of such features provides both strong reflectors and shadow zones. The system is designed to be operated in water depths of 10 to 20 percent of the swath scan's half width. Here that would require 10 meters of water beneath the transducers. Hence our operation of the system in under 2 meters of water is less than ideal.

Data reduction and interpretation rely upon subjective evaluations of sonogram. Usually the scientist will indicate the features she or he sees and the impressions she or he has of the image on a map of the track lines. The positions of features noted on the sonograms are marked on the map of track lines.

The sub-bottom profiler was a Datasonics system including an SBP-220 transceiver and a transducer vehicle. Data were recorded on an EPC 4800 graphics recorder. The recorder was operated with a 31 ms ($16^{-1}$ s) scan yielding a full scale covering approximately 24 m. The Datasonics is a two channel system, one channel operating at 7 kHz and up to 12 kw; the second channel operates at 200 kHz and 1 kw. The lower frequency channel provides the sub-bottom information. The system operates on the principles of seismic reflection. Bottom penetration varies from only a meter or less to many meters.

Data reduction is more straight forward than with the side-scan sonograms. The scientist either traces the graphic record and successively reduces it to a manageable size or transcribes it to a scale corrected profile. In determining depth of reflectors, we use the arbitrary but relatively standard 1,500 m $s^{-1}$ for the speed of sound in both sea water and unconsolidated, shallow sediments. Then the scientist interprets the individual and collected profiles looking for continuity of reflectors, unconformities, and other features. In this survey, we placed particular attention on looking for isolated, hard reflectors or for indications of filled shallow trenches.

## RESULTS

Although all systems functioned well, we were not able to discern anything indicative of colonial habitation. Indeed the features identified on the sonogram suggest a significant amount of disturbance of the bottom such that any artifacts that might have been present probably would have been affected. Figures 2 and 3 depict the track lines for the side-scan sonar and sub-bottom profile surveys.

As an example of what can be seen on the side-scan sonar record, Figure 4 depicts the groins on the seawall near Church Point and the locations of the trees in the very shallow, nearshore waters. The linear feature in the appears to be a wall, perhaps constructed along a past location of the shoreline. Figure 5 is another side-scan image which shows disturbance to the bottom and the effects of very shallow water on the system.

Figure 6 is an example of a sub-bottom profiles together with an interpretive drawing. It is possible that some of the fill seen in the profile is the result of spoil disposal from past channel dredging as well as from natural causes.

Figure 7 is a reproduction of a portion of a sketch map depicting locations of past dredging activities in the area. This map, obtained after the field surveys were completed, demonstrates how and why the river bottom sediments have been disturbed.

Finally, empirical observations during the surveys suggest that the river's currents are of sufficient strength that the bottom and near sub-bottom probably have been reworked extensively. At all times during the surveys the water was so turbid that the bottom was obscured from view in even less than a meter of total water depth.

## CONCLUSION

Despite a successful field exercise, we were unable to locate anything on the bottom of the James River between the Virginia Department of Transportation Ferry Pier and the Church Point area of Jamestown Island indicative of early colonial habitation. Even though failure to find an artifact is not proof of the absence of artifacts, the degree of disturbance of the area is so great that the presence of any substantial artifacts is unlikely.

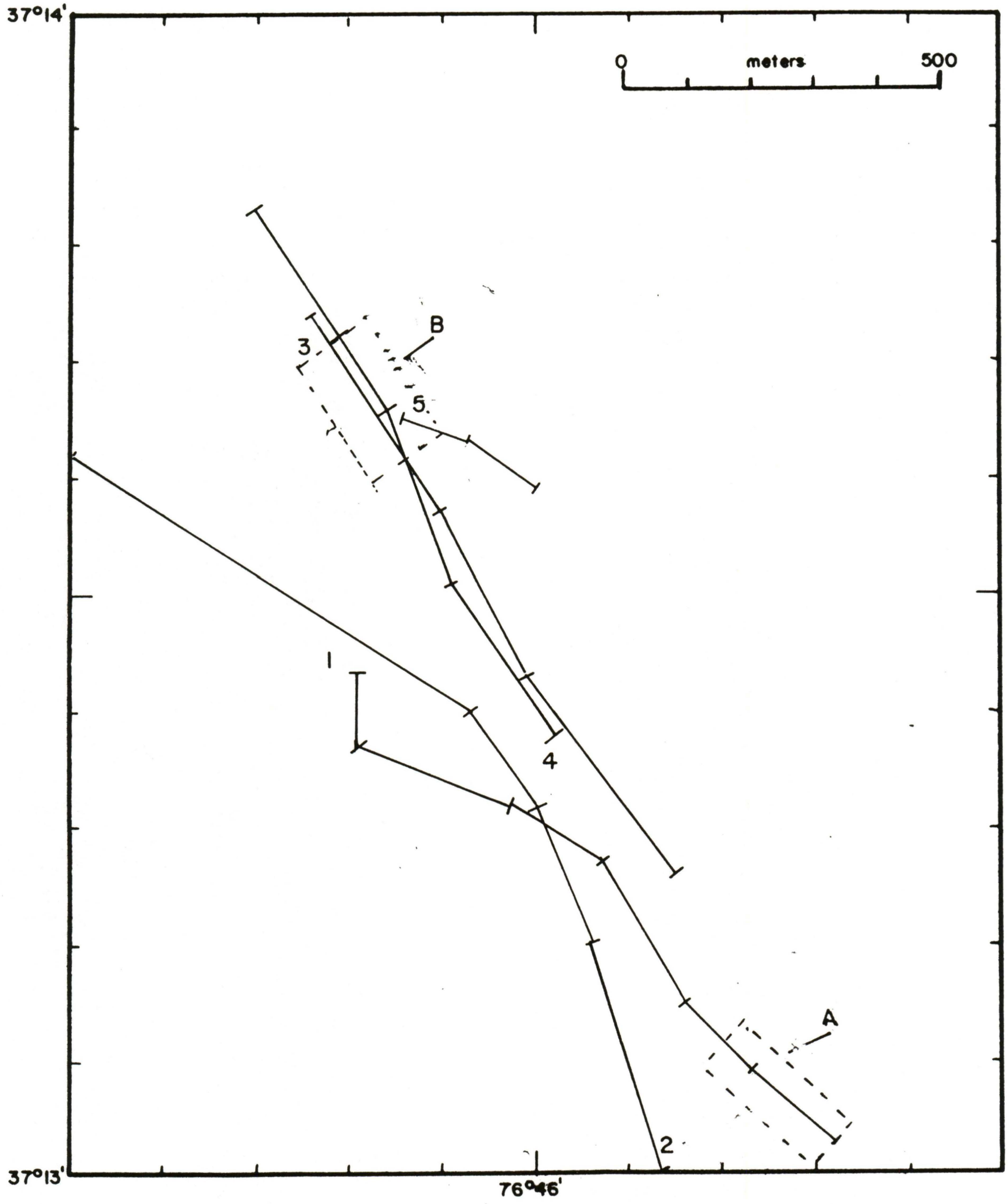



Figure 2. Track lines covered by the side-scan sonar survey. The locations of the areas shown in Figures 4 and 5 are indicated by "A" and "B," respectively. Latitude and longitude shown on the map is the that derived from the loran-C microprocessor. To align positions on this map with Figure 1, this map needs to be shifted 1.95 km at 238°.

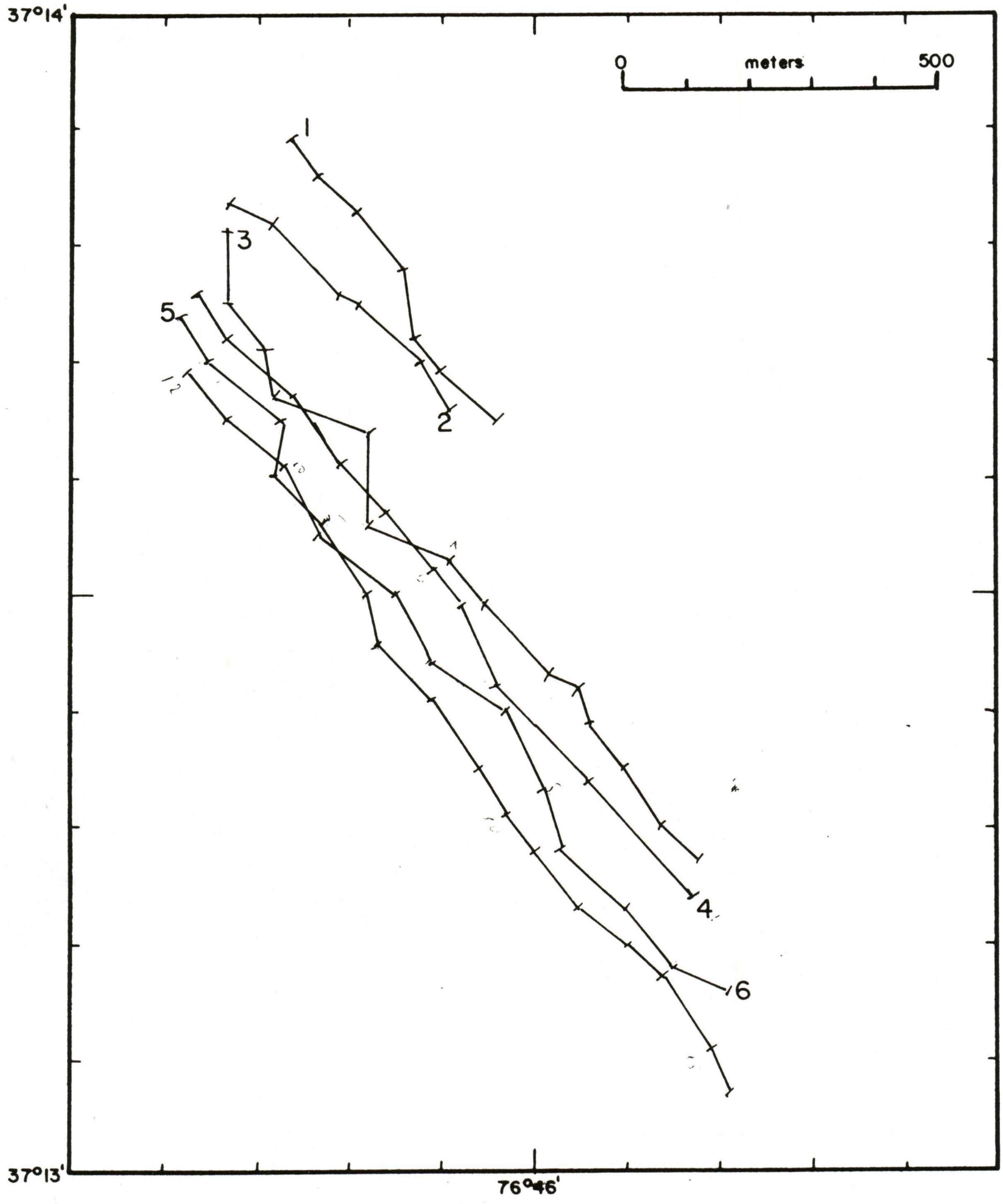
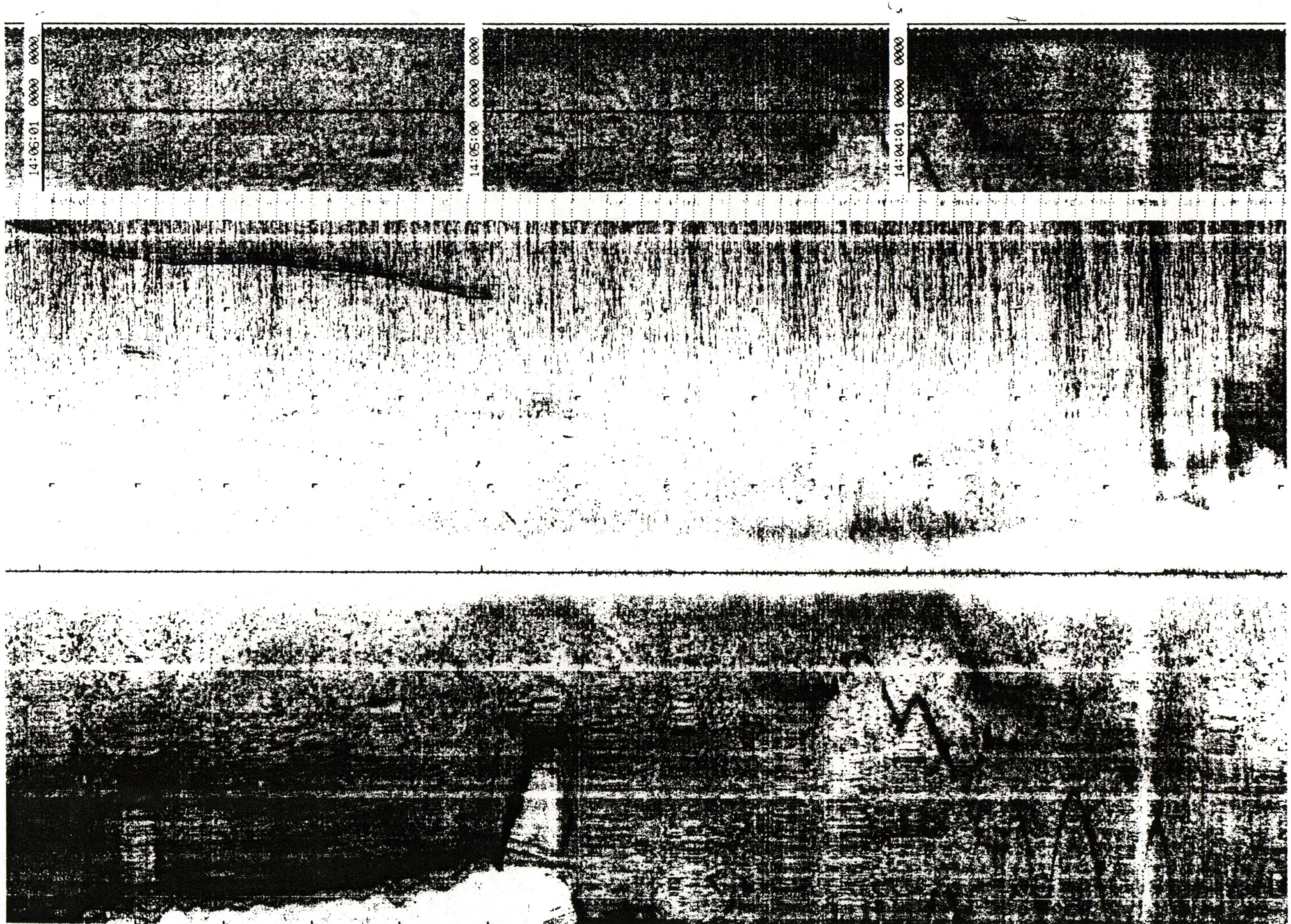



Figure 3. Track lines covered by the sub-bottom profile survey. Latitude and longitude are as described in Figure 2.

Figure 4. A: A portion of side-scan sonar record from Line 1 (see Figure 2 for location) depicting two groins and several trees to the left of the track line and an undefined, sharp, linear feature to the right. The darker tone to the left and lighter tone to the right are a result of the bottom's slope from shallow water on the left to deeper water on the right. B: An annotated sketch of the sonogram shown in A.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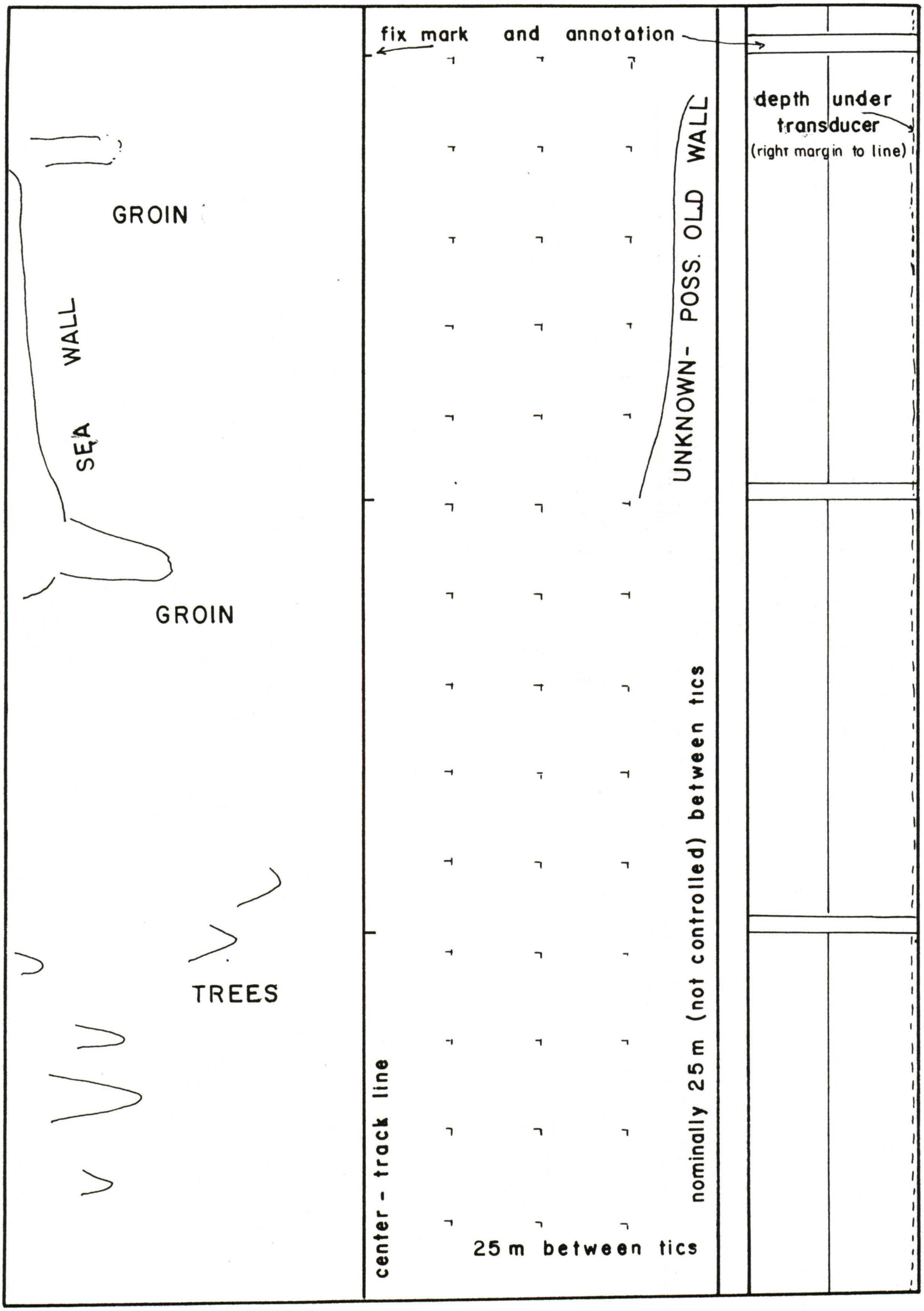
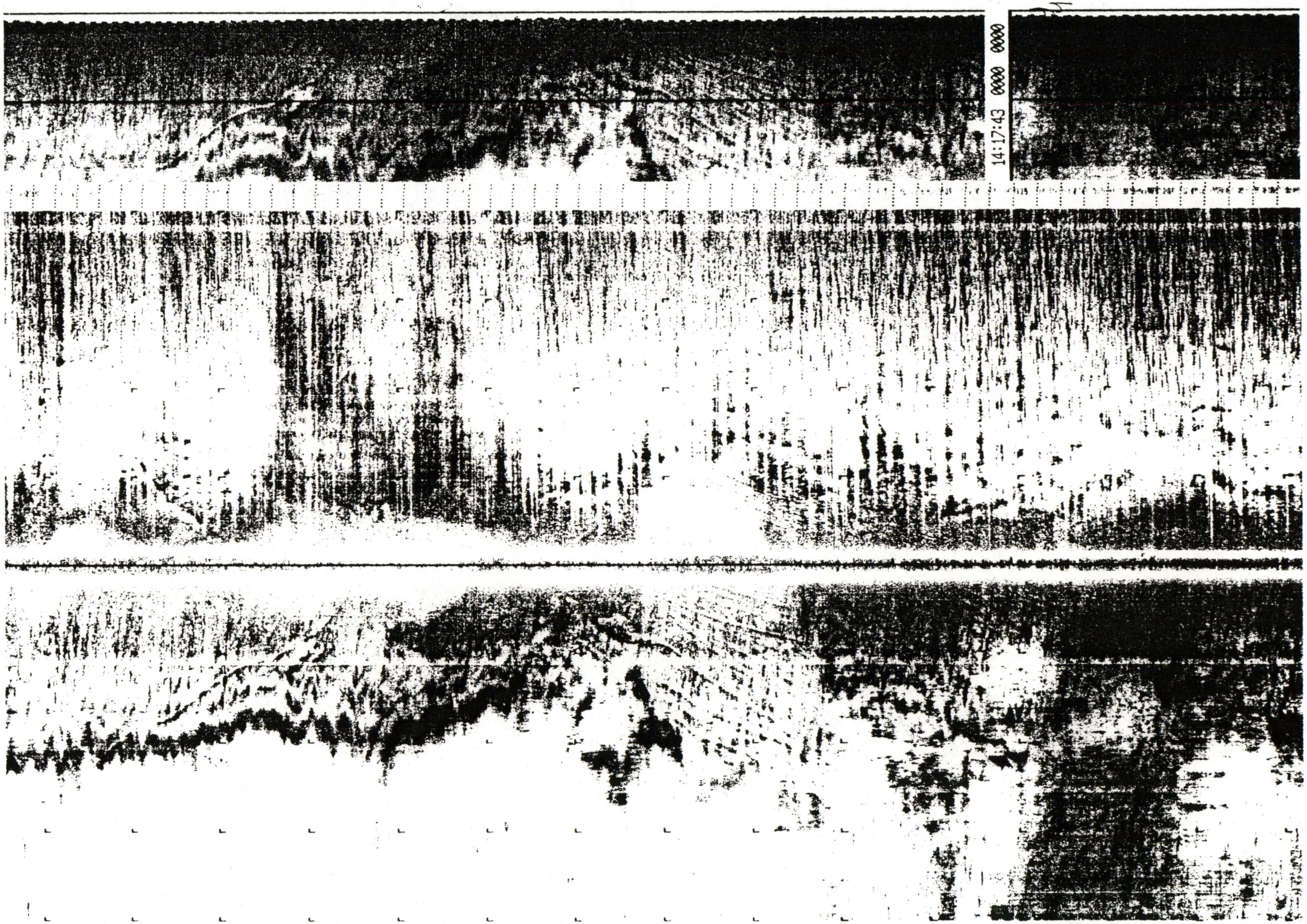
14:05:00 0000 0000
14:04:01 0000 0000



fix mark and annotation
depth under transducer
(right margin to line)
GROIN
SEA WALL
UNKNOWN- POSS. OLD WALL
GROIN
TREES
nominally 25 m (not controlled) between tics
center - track line
25 m between tics

Figure 5. A: A portion of the side-scan sonar record from Line 3 (see Figure 2 for location) depicting the very disturbed character of the bottom. The same scars are depicted on Line 4. The portion of the sonogram far to the left of the track line probably is obscured by the very shallow water. The area of nearly parallel linear features near the center of the record is suggestive of past dredging scars and the individual linear features are similar tho those made when vessels ground. B: An annotated sketch of the sonogram shown in A, the defining parameters are the same as shown on Figure 4B.


14:17:43 0000 0000 0000

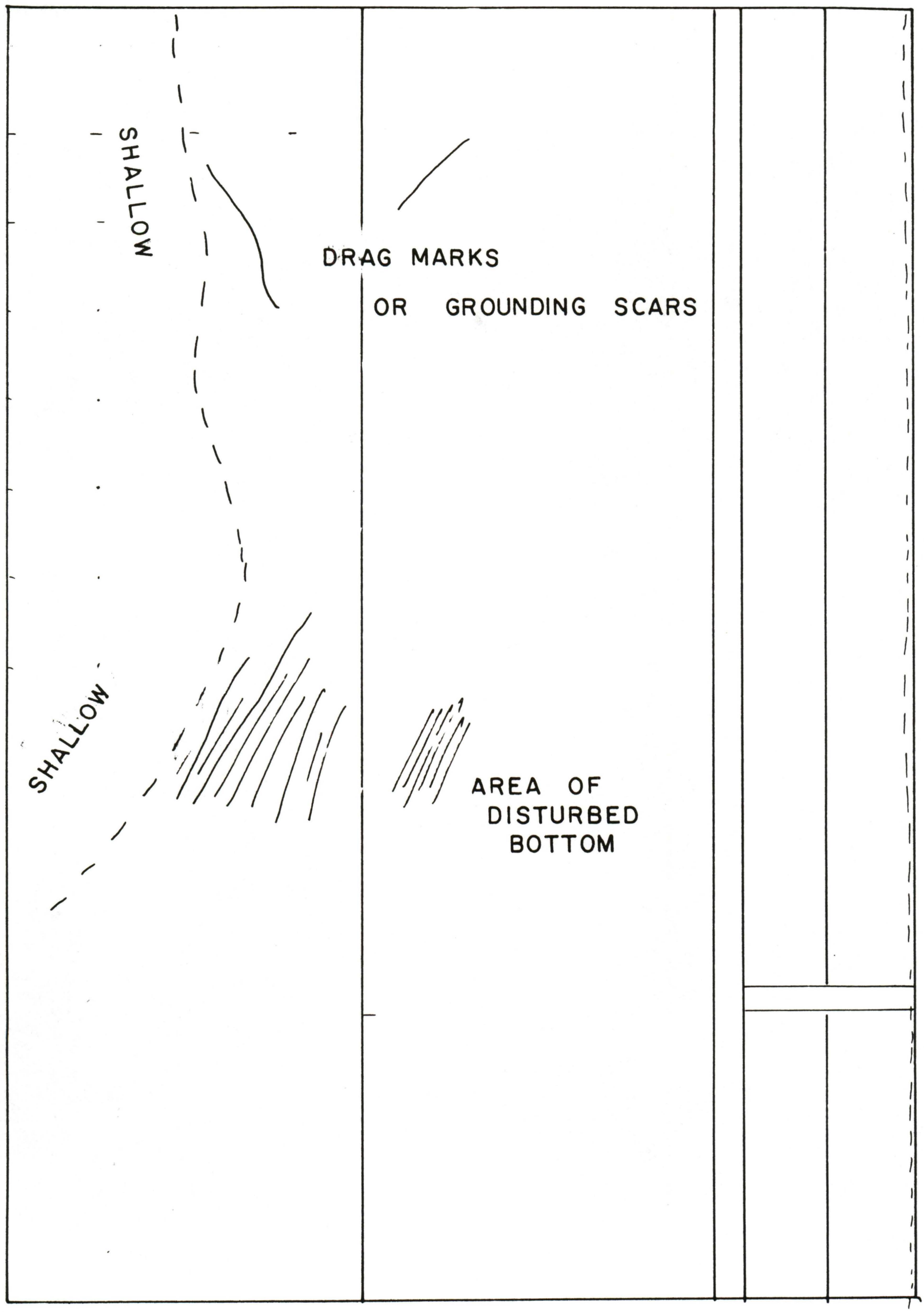
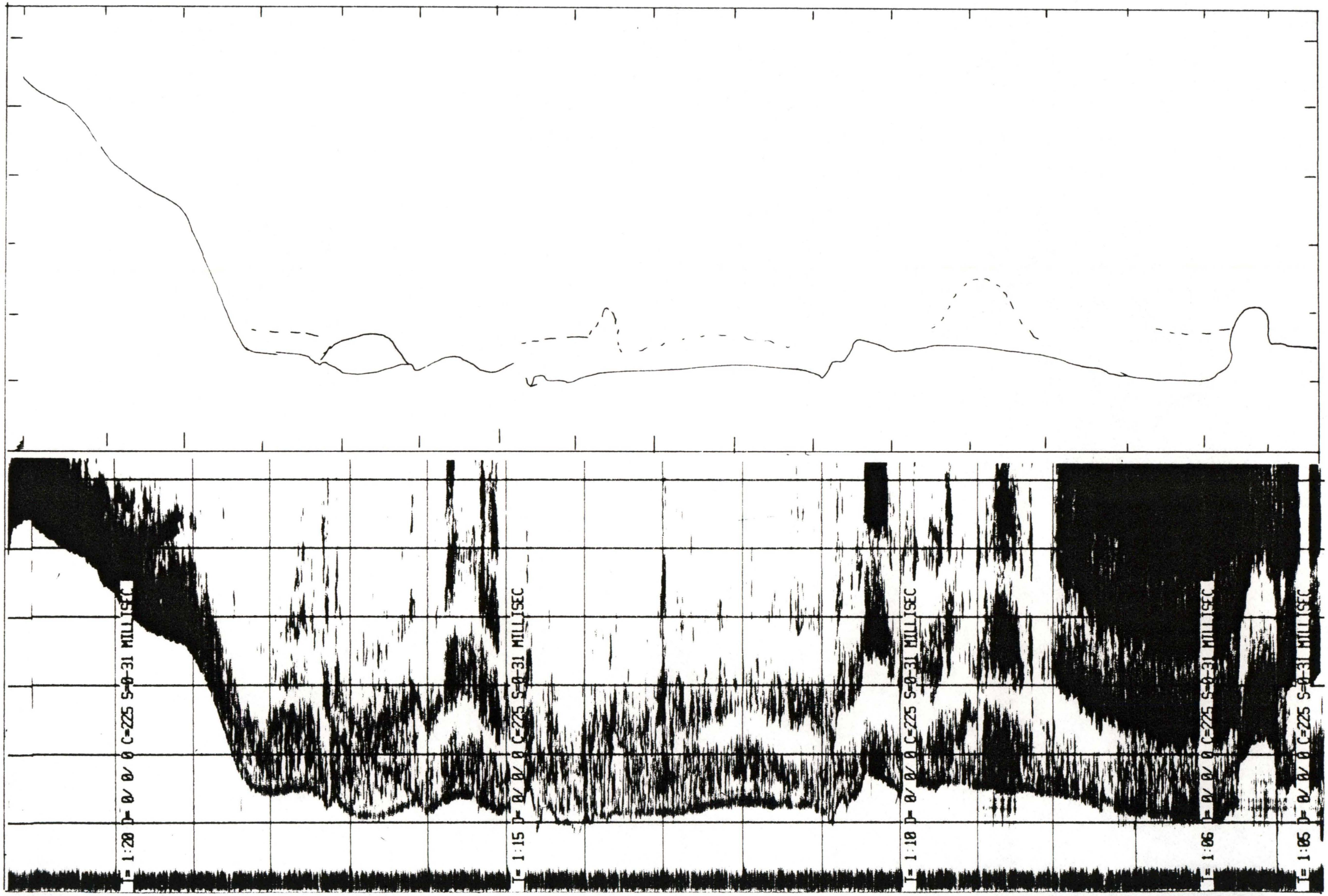

SHALLOW
DRAG MARKS
OR GROUNDING SCARS
SHALLOW
AREA OF
DISTURBED
BOTTOM

Figure 6: Sub-bottom profile Line 5 (see Figure 3) and an interpretative drawing. The channel to the left is the dredged channel adjacent to the ferry pier. Two filled channels are evident in the sub-bottom surfaces. The two areas of fill are clearly evident. Vertical scale is 2.3 m per division. Vertical lines are 1 minute in time apart.


T= 1:20 D= 0/ 0/ 0 C=225 S=0-31 MILLISEC
T= 1:15 D= 0/ 0/ 0 C=225 S=0-31 MILLISEC
T= 1:10 D= 0/ 0/ 0 C=225 S=0-31 MILLISEC
T= 1:06 D= 0/ 0/ 0 C=225 S=0-31 MILLISEC
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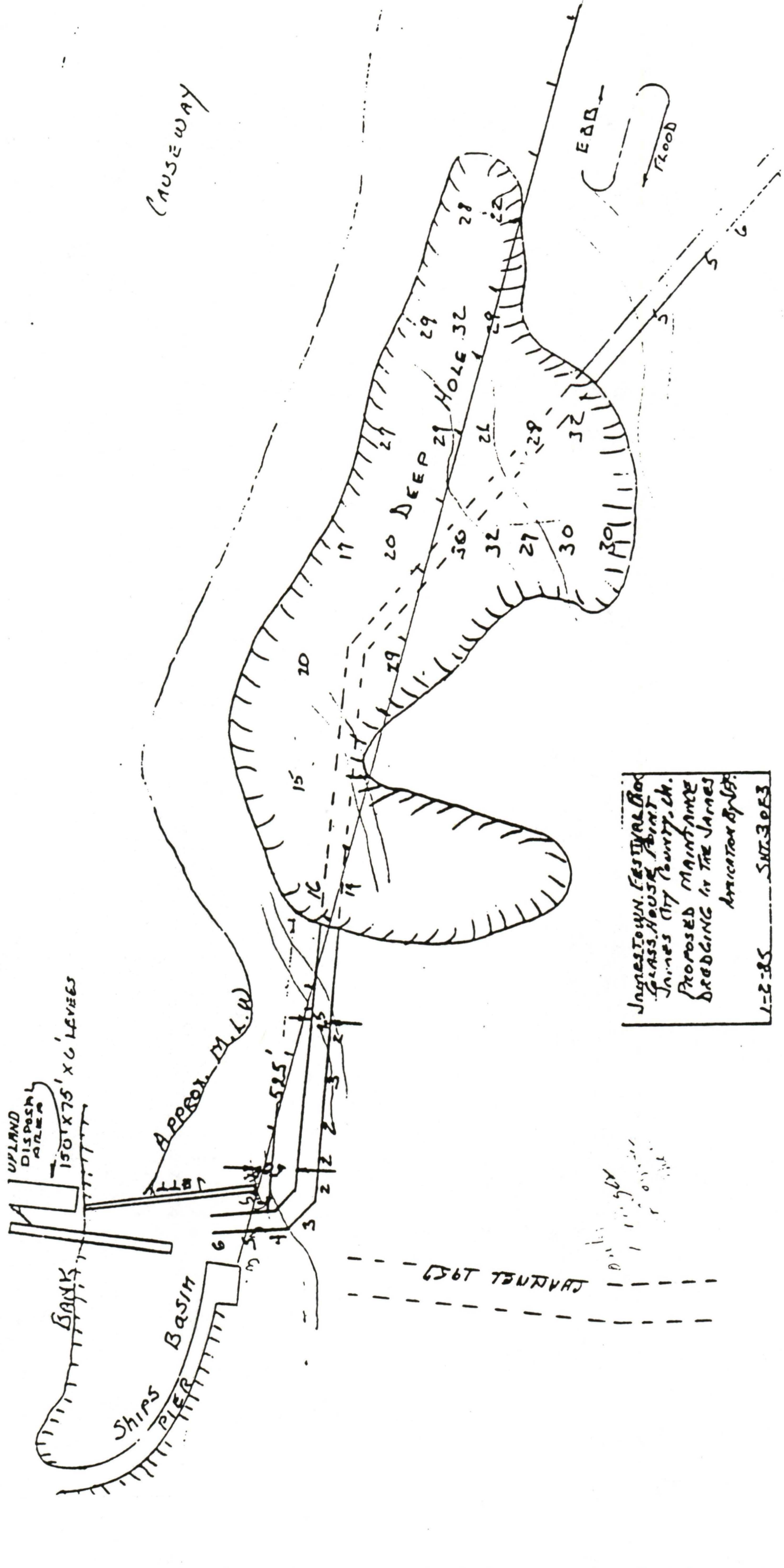



Figure 7: A copy (reduced) of a sketch map depicting the locations of past dredging activities in the study area.

# APPENDICES

APPENDIX 1: Loran derived latitude and longitude for fixes along the side-scan sonar survey.

LINE 1

37 13.43 76 46.19
37 13.37 76 46.19
37 13.32 76 46.03
37 13.27 76 45.93
37 13.15 76 45.84
37 13.09 76 45.77
37 13.03 76 45.68

LINE 2

37 13.00 76 45.77
37 13.20 76 45.94
37 13.32 76 46.00
37 13.40 76 46.07
37 13.75 76 46.75

LINE 3

37 13.74 76 46.24
37 13.57 76 46.10
37 13.43 76 46.01
37 13.26 76 45.85

LINE 4

37 13.38 76 45.98
37 13.51 76 46.09
37 13.66 76 46.16
37 13.72 76 46.21
37 13.83 76 46.30

LINE 5

37 13.65 76 46.14
37 13.63 76 46.07
37 13.59 76 46.00

APPENDIX 2: Loran derived latitude and longitude for fixes along the sub-bottom profile survey.

LINE 1

| | | | |
|---|---|---|---|
| 37 | 13.89 | 76 | 46.26 |
| 37 | 13.86 | 76 | 46.23 |
| 37 | 13.83 | 76 | 46.19 |
| 37 | 13.78 | 76 | 46.14 |
| 37 | 13.72 | 76 | 46.13 |
| 37 | 13.69 | 76 | 46.10 |
| 37 | 13.65 | 76 | 46.04 |

LINE 2

| | | | |
|---|---|---|---|
| 37 | 13.66 | 76 | 46.09 |
| 37 | 13.70 | 76 | 46.12 |
| 37 | 13.75 | 76 | 46.19 |
| 37 | 13.76 | 76 | 46.21 |
| 37 | 13.82 | 76 | 46.28 |
| 37 | 13.84 | 76 | 46.33 |

LINE 3

| | | | |
|---|---|---|---|
| 37 | 13.81 | 76 | 46.33 |
| 37 | 13.75 | 76 | 46.29 |
| 37 | 13.71 | 76 | 46.28 |
| 37 | 13.67 | 76 | 46.18 |
| 37 | 13.64 | 76 | 46.18 |
| 37 | 13.56 | 76 | 46.09 |
| 37 | 13.53 | 76 | 46.06 |
| 37 | 13.49 | 76 | 46.05 |
| 37 | 13.43 | 76 | 45.98 |
| 37 | 13.42 | 76 | 45.95 |
| 37 | 13.39 | 76 | 45.94 |
| 37 | 13.35 | 76 | 45.90 |
| 37 | 13.30 | 76 | 45.86 |
| 37 | 13.27 | 76 | 45.82 |

LINE 4

| | | | |
|---|---|---|---|
| 37 | 13.24 | 76 | 45.83 |
| 37 | 13.34 | 76 | 45.94 |
| 37 | 13.42 | 76 | 46.04 |
| 37 | 13.49 | 76 | 46.08 |
| 37 | 13.52 | 76 | 46.08 |
| 37 | 13.57 | 76 | 46.16 |
| 37 | 13.61 | 76 | 46.21 |
| 37 | 13.67 | 76 | 46.26 |
| 37 | 13.72 | 76 | 46.33 |
| 37 | 13.76 | 76 | 46.36 |

LINE 5

| | | | |
|---|---|---|---|
| 37 | 13.74 | 76 | 46.38 |
| 37 | 13.70 | 76 | 46.35 |
| 37 | 13.65 | 76 | 46.27 |
| 37 | 13.60 | 76 | 46.28 |
| 37 | 13.56 | 76 | 46.25 |
| 37 | 13.50 | 76 | 46.18 |
| 37 | 13.46 | 76 | 46.17 |
| 37 | 13.41 | 76 | 46.11 |
| 37 | 13.45 | 76 | 46.06 |
| 37 | 13.31 | 76 | 46.03 |
| 37 | 13.28 | 76 | 46.00 |
| 37 | 13.23 | 76 | 45.95 |
| 37 | 13.20 | 76 | 45.90 |
| 37 | 13.17 | 76 | 45.86 |
| 37 | 13.11 | 76 | 45.86 |
| 37 | 13.07 | 76 | 45.82 |

LINE 6

| | | | |
|---|---|---|---|
| 37 | 13.16 | 76 | 45.79 |
| 37 | 13.18 | 76 | 45.85 |
| 37 | 13.23 | 76 | 45.90 |
| 37 | 13.28 | 76 | 45.97 |
| 37 | 13.33 | 76 | 45.99 |
| 37 | 13.40 | 76 | 46.03 |
| 37 | 13.44 | 76 | 46.11 |
| 37 | 13.50 | 76 | 46.15 |
| 37 | 13.55 | 76 | 46.23 |
| 37 | 13.61 | 76 | 46.27 |
| 37 | 13.65 | 76 | 46.33 |
| 37 | 13.69 | 76 | 46.37 |

APPENDIX 3: Chart measured and loran derived positions for known locations within the area.

DOCK, JAMESTOWN MARINA

| | | |
|---|---|---|
| 37 14.18 | 76 45.63 | loran |
| 37 13.56 | 76 46.75 | chart |

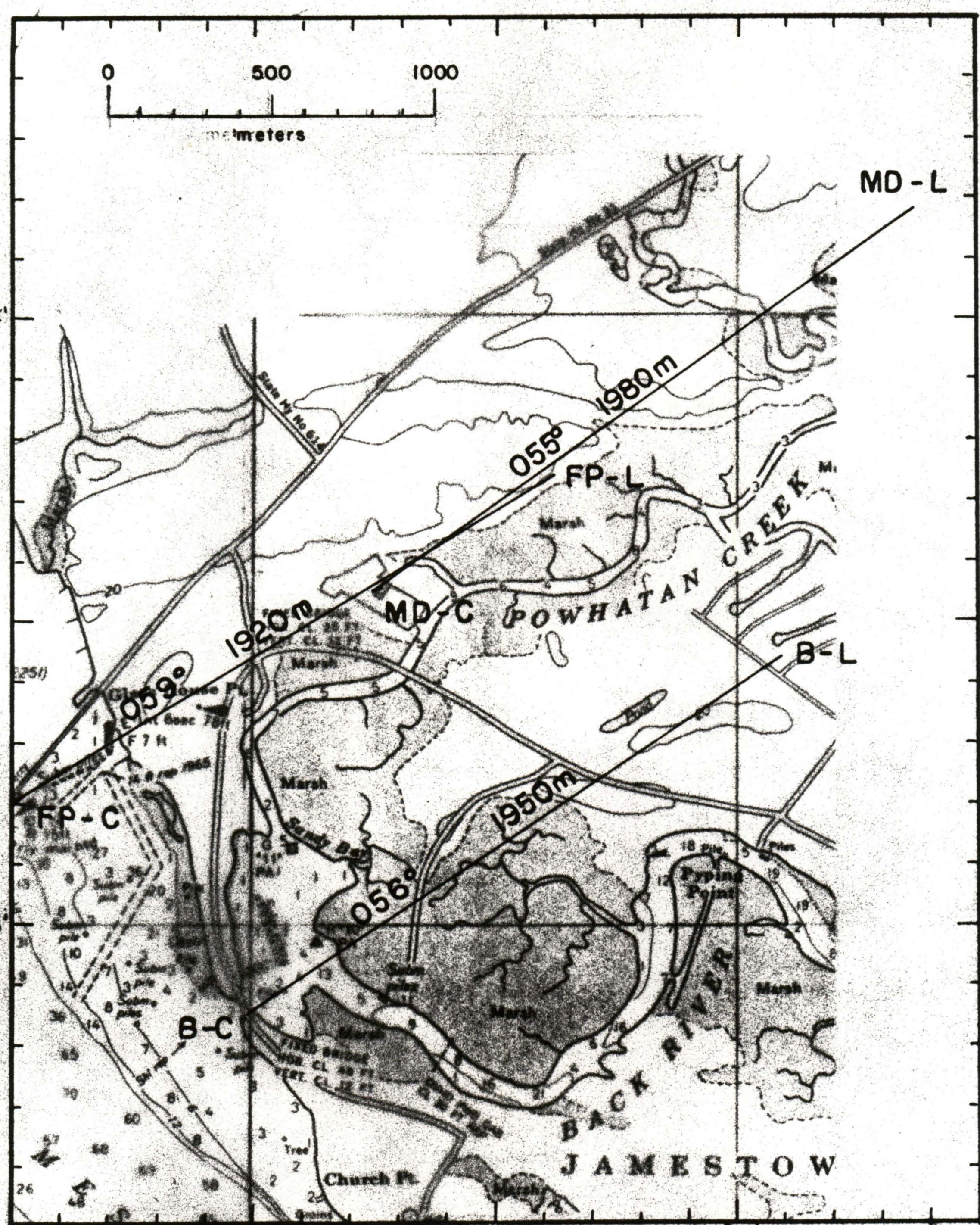
FERRY PIER, RIVER END

| | | |
|---|---|---|
| 37 13.74 | 76 46.38 | loran |
| 37 13.20 | 76 47.50 | PC |

BRIDGE

| | | |
|---|---|---|
| 37 13.44 | 76 45.91 | loran |
| 37 12.85 | 76 47.01 | chart |

APPENDIX 4: Plot of loran and real positions of sites listed in Appendix 3. (next page)


0
500
1000
meters
MD - L
37°14'
1980m
055°
FP-L
POWHATAN CREEK
MD-C
1920m
B-L
059°
FP-C
1950m
056°
37°13'
B-C
BACK RIVER
JAMESTOW
Church Pt.
76°47'
76°46'